rendered on flexible visual display layer **102**, to further improve user experience, by providing the user with tactile sensations when interacting with the rendered visual images.

[**0024**] More specifically, flexible visual display layer **102** is employed for rendering visual images, such as the example "arrow" and "select" key array image **108** depicted.

[**0025**] For the embodiment, similar to conventional flat panel displays, flexible visual display layer **102** comprises a number of thin-film transistors forming a matrix of pixels (not shown) to facilitate visual image rendering.

[**0026**] However, unlike conventional flat panel displays, the thin-film transistors are plastic thin-film transistors, thus rendering flexible visual display layer **102** to be flexible, as illustrated in **FIG. 2**, where layer **102** is illustrated in a flexed position.

[**0027**] Referring back to **FIG. 1**, tactile display layer **104** is employed to tactilely enhance the visual images rendered on flexible visual display layer **102**. As alluded to earlier, tactile display later **104** includes a number of pistons **106**, which may be selectively activated or raised, as illustrated in **FIG. 3**.

[**0028**] As described earlier, flexible visual display layer **102** and tactile display layer **104** are disposed adjacent to each other. More specifically, flexible visual display layer **102** has a viewing side **103***a* and a back side **103***b*, and tactile display layer **104** is disposed adjacent to flexible visual display layer **102** on the back side **103***b* of flexible visual display layer **102**. Depending on the intended usage or orientation of the final assembly, viewing side **103***a* may also be referred as the top side or the front side, whereas back side **103***b* may also be referred as the bottom side.

[**0029**] Thus, as pistons **106** of tactile display layer **104** are selectively activated or raised, different portions or areas of flexible visual display **102** are being pushed against by the activated/raised pistons. Since, flexible visual display **102** is designed to be flexible, the corresponding areas being pushed by the selectively activated/raised pistons **106**, present to the user a raised condition, as illustrated by **FIG. 5**.

[**0030**] Therefore, if a key or button image, or a menu or list item is rendered on the area of flexible visual display layer **102** being pushed by the selectively activated/raised pistons **106**, the user perceives a raised key or button, or raised menu or list item.

[**0031**] In various embodiments, pistons **106** may be further provided with different degree of resistance to a user touching or pushing against them. Accordingly, depending on the application and the desire of the designer, different degree of hardness may be manifested for the user.

[**0032**] As a result, the present invention enables a designer to present to a user with an interface on demand, where the interface may include keys, buttons, menu/list items that are dynamically formed, and non-persistent, and yet these dynamically formed non-persistent keys, buttons, and menu/list items may provide an interacting user with some degrees of tactile sensations that approximate permanently formed "hard" keys/buttons.

[**0033**] Still referring to **FIG. 1**, in various embodiments, flexible visual display layer **102** has a thickness in the range of 0.1 mm to 1.0 mm. In alternate embodiments, flexible visual display layer **102** may be thicker or thinner.

[**0034**] Further, in alternate embodiments, other circuit technology beside plastic thin-film transistors may be employed to provide the visual image rendering capability of sub-assembly **100** with the desired thinness and flexible attribute.

[**0035**] **FIGS. 4***a*-**4***b* illustrate the alignment relationships between the pixels of the flexible visual display layer **102** and pistons **106** of tactile display layer **104**, in accordance with two embodiments. In various embodiments, flexible visual display layer **102** comprises m×n pixels **105**. Typically, although not necessarily, m and n are integers, and equal to a power of 2. Similarly, tactile display layer **104** comprises p×q pistons **106**. Typically, although also not necessarily, p and q are integers, and also equal to a power of 2.

[**0036**] For the embodiment of **FIG. 4***a*, the pixels of flexible visual display layer **102** and the pistons **106** of tactile display layer **104** are 1:1 aligned. That is, the size of each pixel **105** and the size of the each piston **106** is approximately the same. In one embodiment, m and n equal p and q respectively.

[**0037**] For the embodiment of **FIG. 4***b*, each piston **106** is aligned with a group of pixels **105**. That is, the size of each piston **106** is approximately that of the size of the group of pixels **105** to which it corresponds. In one embodiment, m and n are multiples of p and q respectively, i.e. 2×, 3× and so forth.

[**0038**] **FIG. 6** illustrates an architectural view of the pistons **106** of the tactile display layer **104** and the companion elements, in accordance with one embodiment. As illustrated, for the embodiment, pistons **106** are connected to a servo mechanism **602** that is responsible for activating or raising pistons **106** as earlier described. Further, for the embodiment, servo mechanism **602** is also responsible for providing resistance to pistons **106** to simulate various degrees of hardness for a user.

[**0039**] For the embodiment, tactile display layer **104** is also provided with sensor **604** coupled to servo mechanism **602** as shown. Sensor **604** is employed to sense a user's interaction with the tactilely enhanced visual image, which as described earlier, may be "emulating" an input key/button.

[**0040**] Sensor **604** enables the sub-assembly **100** to be touch sensitive, in addition to rendering tactilely enhanced visual images.

[**0041**] For the embodiment, both servo mechanism **602** and sensor **604** are controlled by controller **606**. In various embodiments, controller **606** is in turn coupled to and controlled by a processor of a host device, e.g. a PDA.

[**0042**] Any one of a number of known servo mechanisms, sensor circuits and controllers may be employed to practice the present invention.

[**0043**] Thus, from the foregoing description, it can be seen that tactilely enhanced visual images may be advantageously provided to improve user experience, by providing a user with tactile sensation when interacting with an interface